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Post-cam contact mechanics in posterior stabilized TKA designs

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Objectives: Posterior Stabilized (PS) TKA designs were introduced to compensate for the resected or deficient PCL. Despite excellent clinical results, concern exists regarding stresses in the polyethylene post, especially because PS TKA is increasingly used for young and active patients who may impose higher loads on their replaced knee. This study's objective is to measure and compare post-cam contact pressures and forces, in several PS designs, during a simulated squat.

Methods: Nine contemporary PS designs of the major manufacturers were implanted in custom-made metal fixtures simulating the tibia and femur. A squat was performed on a knee kinematics simulator in static and dynamic conditions, between 10° of hyperextension and full flexion (150°). The vertical load on the ankle was produced by a variable load of the quadriceps and constant forces in the medial and lateral hamstrings. Anterior and posterior contact pressure, contact area and contact force, in the post were measured using Tekscan sensors.

Results: All designs showed a gradual increase in contact pressure during flexion. Post-cam contact pressures were significantly different for some designs. More conforming post-cam designs demonstrated greater contact area and less contact pressure. In all cases, contact pressure exceeded the yield strength of polyethylene in part of the contact area, similar to what occurs in femoro-tibial contact stresses.

Conclusions: Contemporary PS TKAs show post-cam pressures during deep squatting that can reach critical values for polyethylene damage. Post-cam design plays an important role in this phenomenon.

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A comparison of the wear of fixed and mobile bearing unicompartmental knee replacements

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Objectives: The purpose of this study was to investigate the influence of bearing design and kinematics on the in-vitro wear performance of unicompartmental knees.

Methods: The wear of two unicompartmental knees was investigated using a knee wear simulator. Two size-matched bearing designs were tested, a fixed bearing (size 3, Sigma High Performance Partial Knee (Sigma HP PK), DePuy) and a mobile bearing (size large, Oxford, Biomet). Three sets of medial and lateral bearings were tested for each design, mounted anatomically in each station. Two kinematic conditions were used, both under anterior-posterior (AP) displacement control; intermediate kinematics for 5 million cycles (Mc) and high kinematics for 3Mc. Intermediate kinematics were defined as maximum femoral axial loading of 2600 N, flexion-extension (F-E) of 0–58°, AP displacement of 0–5 mm, and internal-external rotation of ±5°. High kinematics used the same profiles for loading, rotation and F-E, but used an increased AP displacement of 0–10 mm.

The lubricant was 25% (v/v) calf serum supplemented with 0.03% (w/v) sodium azide solution. Wear was assessed gravimetrically at 1, 3 and 5 Mc for intermediate kinematics, and at 1 and 3 Mc for high kinematics, and moisture uptake was compensated for using unloaded soak controls. Statistical analysis was performed using one way ANOVA and significance was taken at $p < 0.05$.

Results: The mean wear rates for the medial/lateral bearings of both designs are shown in Table 1. The wear rates were higher under high kinematics compared with intermediate kinematics, but this increase was not statistically significant ($p > 0.05$). There was no significant difference comparing the mean wear rates of the medial and lateral bearings within a design, under both high and intermediate kinematics, although the mean wear rates were higher in the medial bearing for both designs ($p > 0.05$). The wear rate of the medial Oxford bearing was significantly higher than the Sigma HP PK under high kinematics ($p < 0.05$). The wear rate of the Oxford lateral bearing was significantly higher than the Sigma HP PK under intermediate kinematics ($p < 0.05$). The mean wear scar areas on the superior surface of the Oxford and Sigma HP PK bearings were 60.7% and 20.8% of the total bearing surface respectively.

Table 1 Mean wear rates

	Mean wear rate (mm^3/Mc, $n = 3$)			
	Sigma HP PK		Oxford	
	High	Intermediate	High	Intermediate
Medial	2.70 ± 1.41	2.12 ± 1.58	7.43 ± 4.12	5.98 ± 5.84
Lateral	1.81 ± 2.70	1.32 ± 0.95	3.89 ± 8.35	3.70 ± 2.10

Conclusions: The lateral bearings for both the fixed and mobile bearing designs had lower wear rates than the medial bearings. The fixed bearing UKR showed reduced wear rates compared with the mobile bearing UKR for both medial and lateral variations. The wear scar areas confirmed the higher conformity of the Oxford bearing, compared with the Sigma HP PK bearing. Low conformity-lower surface wear area in fixed bearing total knee replacement has previously been shown to be a low wearing implant option. The difference in wear rates of the two designs may also be affected by the materials, as the Sigma HP PK implant used a cross-linked GUR1020 polyethylene, and the Oxford bearing was an argon-packaged compression moulded polyethylene. This study has demonstrated that under in-vitro wear test conditions, a relatively low conforming fixed UKR shows reduced wear, in both medial and lateral bearings, compared with a more conforming AP sliding mobile bearing.

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Are Kozinn-Scott contra-indications correct for a mobile bearing unicompartmental knee replacement?

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Objectives: Kozinn and Scott have made recommendations about contra-indications for unicompartmental knee replacement (UKR). They suggest that patients younger than 60, weight > 82 kilograms, patients with exposed bone in patella-femoral compartment or patients who are physically active/perform heavy labour should not be offered a UKR. In addition, chondrocalcinosis is a contra-indication. These strict selection criteria are based on the experience with fixed bearing UKAs and are more intuitive than evidence based. The Oxford UKR has a fully congruous mobile bearing and has been shown to have minimal wear. Over the past 25 years, the Oxford Group has followed a standardised protocol for patient selection for UKR. We ignore patella-femoral joint pathology, chondrocalcinosis, patient's age, weight and activity level when deciding the suitability for UKR.

The aims of this study are two-fold.

1. To confirm the suitability of the Kozinn Scott criteria for selecting a patient to undergo unicompartmental knee replacement (UKR).
2. To compare the results and survivorship of UKR patients when they fall within the Kozinn Scott criteria with those who are outside the recommended criteria.